War Section.

President—Surgeon Rear-Admiral Sir Robert Hill, K.C.M.G., C.B., C.V.O., R.N.

Scurvy: With Special Reference to Prophylaxis in the Royal Navy.[1]

By Surgeon Rear-Admiral Bassett-Smith, C.B., C.M.G., R.N.

In bringing up the subject of scurvy for discussion, I know well that it is one which has been very fully investigated and ably treated by a large number of distinguished persons, but it is of particular interest to all those who have to maintain the health and well-being of our sailors.

In the days of the old sailing ships, with voyages of extended duration, the danger of scurvy was much greater than it is now, little was known of the ætiology of the disease, and catering difficulties were much more marked. Dr. Lind and Sir Gilbert Blane, the pioneers of naval hygiene, were both very active in studying and endeavouring to eradicate this scourge of the Navy. Fresh fruit and vegetables, as prophylactic and curative agents for scurvy, had been known to the Dutch as far back as 1564, and these had been successfully employed in the fleet by Sir Robert Hawkins in 1600, but the use of orange and lemon juice had been more or less forgotten until Dr. Lind insisted on their value. He, however, recommended *preserved* juice for use on long voyages. The fresh fruit juice was concentrated by *heat* to a thick syrup; as this was done in glazed earthenware vessels soluble lead salts were formed and Lind drew attention to this danger which he

[1] At a meeting of the Section, held May 10, 1920.

referred to as "Death in the Pot." Trotter strongly opposed the use of this form of preserved juice as it was said to undergo fermentation and become mouldy. Unfortunately its issue to the crews in Cook's famous voyage of 1773-74 did not prevent scurvy breaking out. It was Gilbert Blane's teaching and powerful influence which brought Lind's recommendation into official use. Sir Gilbert Blane in 1757 pointed out the importance of cleanliness, sufficient ventilation, and absence of damp in ships, and the need of a supply of lemon juice for the prevention of scurvy. It was, however, not until 1796, when Blane was one of the Commissioners of the Navy Board, that the use of lemon juice was ordered as an essential part of the naval dietary, and this quickly resulted in the practical disappearance of scurvy from the service afloat. In 1782, two-thirds of an ounce of lemon juice per man, *per diem*, protected the whole ship's company of H.M.S. *Suffolk* during a voyage of twenty-three weeks without touching port. In a discussion on the probable causes of the disease, which he attributed to the lack of a "certain element which is necessary for growth and repair," Blane foreshadowed the present deficiency theory.

From that time to the present, lime juice has been a standing ration but its efficacy has disappeared. The reason for this has been ably shown by Mrs. Alice Henderson Smith. As originally prepared the lime juice was made from sweet limes, *Citrus medica*, with lemons, imported chiefly from Spain. In 1793 war stopped these supplies, but in 1802 delivery was resumed and scurvy, which had obtained a temporary hold, was again almost eliminated. About 1860, by the development of the cultivation of limes in the West Indies, a large quantity was made available, and the contracts entered for the Navy caused these, the sour lime, *Citrus medica var. acida*, to supersede the sweet limes and lemons formerly in use, and for a time the new lime juice was believed to be better than the old. In Ross's Polar expedition the original lemon juice had been issued, but Sir G. Nares in 1875 was provided with the new West Indian lime juice. The general conditions of the two expeditions were very similar but while the former escaped scurvy, Sir George Nares's men suffered severely from it in spite of the regular issue of the lime juice, thus demonstrating the failure of the new preparation as a prophylactic. The sister ship in the latter expedition, the *Investigator*, was supplied with lemon juice, and for twenty-seven months after leaving home she had few cases, though the crew suffered great hardships. In three and a half years she had only three deaths from scurvy whereas Nares had the same number in one year.

The evidence is clear that lemon juice is far more effective than lime juice in preventing scurvy and this has been fully confirmed by the large number of laboratory experiments carried out at the Lister Institute, London, and elsewhere, which have determined exactly their relative values for the purpose. Lemon juice and sweet limes have therefore been found to repair a deficiency which, if not rectified, induces scurvy, and the consumption of these juices is curative for the same disease. This is in accordance with modern teaching which attributed the condition to a deficiency of a certain accessory factor known as scurvy vitamine. This factor is found in living vegetable (and secondarily in animal) tissue; in largest amount in fresh fruit, green vegetables, and growing pulses, and, to a less extent, in roots and tubers. Young vegetables contain more than old. It is present in small amount in fresh meat and milk. It has not been found in yeast, fats, dry cereals and pulses, but exists to a certain extent in canned tomatoes. The antiscurvy food factor is sensitive to high temperatures and if exposed to them it rapidly loses its efficacy; the presence of alkali is also detrimental.

Recent History.—Much has been written of the prevalence of scurvy, during and since the war, among the combatant forces and in the civil populations chiefly affected in war areas. Of the former those in Mesopotamia suffered very severely and Colonel Willcox, in his excellent communications,[1] has described the reasons for the outbreak very fully. The high incidence amongst the native troops at Kut, in comparison with that of the Europeans, is explained on dietary grounds; the latter had fresh meat to supplement their meagre diet and the former were more susceptible owing to diminished vitality from preventable causes. He states that the knowledge we then possessed for the prevention of scurvy and beri-beri was not fully appreciated and acted upon by those in authority, i.e., that the food must have the necessary accessory factors as well as sufficient calories as estimated by the protein, carbohydrates, and fat. The fact that over 11,000 cases of scurvy occurred in the last six months of 1916 indicates the importance of the subject. The following table shows the amount of scurvy in the Indian troops and beri-beri in the British :—

Year	Scurvy (Indian)	Beri-beri (British)
1916	11,445	104
1917	2,197	84
1918	825	51

[1] See *Proceedings*, xiii (Sect. Therap.), p. 7.

The crews of British men-of-war were also affected to a small extent, and as has been shown repeatedly by the endemic presence in the Persian Gulf of ship beri-beri, this is a question of some importance, more particularly in times of extra strain as was the case in these years. Much has been done to prevent these outbreaks by increasing and supplementing the diet, but climatic conditions in that area always make the provision of efficient food supplies difficult.

In other war areas, Serbia and the remainder of the Balkans, famine conditions have necessarily given rise to an enormous number of scurvy cases. In Northern Russia it is very prevalent each winter, particularly in the prisons. Even on the Western Front the cases of incipient scurvy were very numerous, due in great part to the use of tinned provisions.

The post-war hardships in the civil populations have induced scurvy and the gallant fight being made by noble-minded individuals of all classes and peoples throws a glimmer of sunshine on what is otherwise a dark and tempestuous horizon. The work in Vienna, by Dr. Chick and others, to ameliorate the sufferings of the infantile population, is particularly noteworthy. From a scientific point of view such an overwhelming mass of cases has increased our knowledge of the clinical features of scurvy enormously and many new facts have been ascertained.

By Japanese investigators the conditions produced in guinea-pigs on a deficiency diet is considered to be similar to that found in ship beri-beri, a disease which undoubtedly links up human scurvy and beri-beri.

The ætiology, thanks to the work of British, American, French and other observers has now been placed on a sure foundation following the elaborate investigations that have, for years, been carried out in establishing the ætiology of beri-beri as a deficiency disease. The close relationship of beri-beri, ship beri-beri, scurvy, and rickets was well shown in a diagram by Darling in 1915 which I here reproduce; it shows the gradation from polyneuritis avium at one end to that of rickets at the other.

He recognized several varieties of beri-beri—infantile beri-beri, asylum beri-beri, wet-and-dry beri-beri (which Vedder and Clark look upon as distinct), the Brazilian type, endemic dropsy, and endemic peripheral neuritis. Darling, with Surgeon-General Gorgas, spent much time in investigating the endemic scurvy found among the miners in the Rand of South Africa. The points of similarity in

the cardiac condition with that of beri-beri were often very marked in the concentric hypertrophy of the right heart and degeneration of the vagus nerves. The disease appeared to depend upon the following factors: Over-milled corn as a chief article of diet, over-cooked corn, over-boiled meat, insufficient vegetables.

Clinically, cases were seen of every degree of severity, from those who had spongy gums only to those with excessive hæmorrhages.

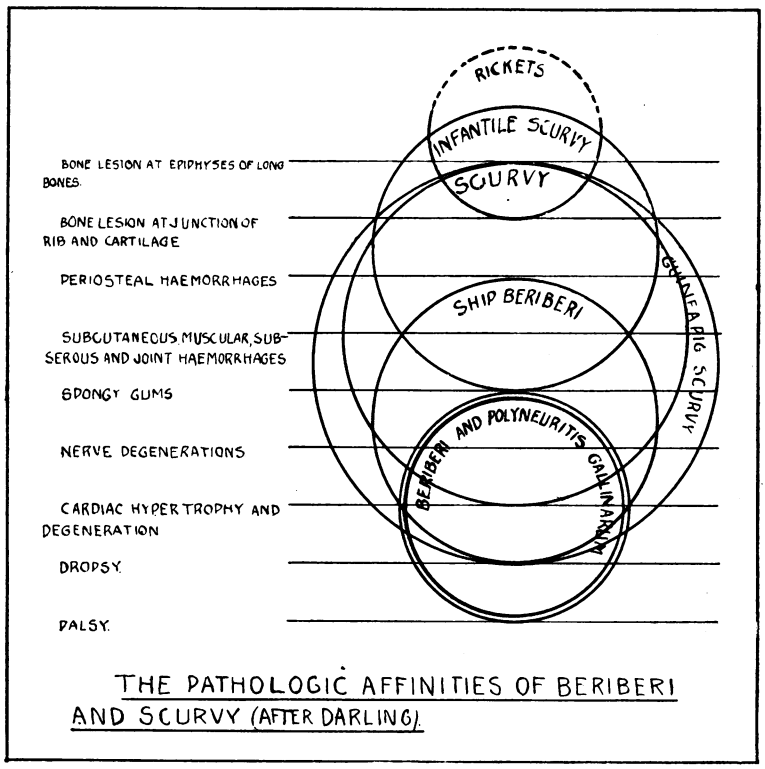

FIG. 1.

Some cases showed marked rickety symptoms with extreme destruction of the chondrocostal junctions, others were similar to beri-beri with cardiac degeneration and changes in the vagus nerves. Personal and racial factors had an unknown influence on the resultant symptoms; a deficiency diet in a tropical African negro miner causes severe scurvy symptoms and in a Cape Colony African labourer mild scurvy, a diet that in some African negroes may cause scurvy will in others produce neuritis. In all cases the knee-jerks were exaggerated. (Those who

have experience in ship beri-beri have often been puzzled by the persistence of knee-jerks in these cases also.)

The Rand scurvy, besides showing the cardiac changes, differs from the ordinary forms found in time of poverty and famine in that it does not so readily yield to treatment. Darling sums up in the following words: "The striking excentric hypertrophy and dilation of the right heart, with extensive fatty degeneration of the muscle, and the severe degeneration of the vagus nerves, in cases of scurvy seen in the Rand,

TABLE I.—SHOWING AFFINITIES AND PATHOLOGIC FEATURES OF SCURVY, BERI-BERI, &c.

Bone lesions at epiphyses of long bones	Rickets	Infantile scurvy	*	Guinea-pig scurvy			
Bone lesions at junction of ribs and cartilage	Rickets	Infantile scurvy	Scurvy	Guinea-pig scurvy			
Subperiosteal hemorrhages		Infantile scurvy	Scurvy	Guinea-pig scurvy			
Joint, subserous, subcutaneous and muscle hemorrhages		Infantile scurvy	Scurvy	Guinea-pig scurvy	Ship beri-beri		
Spongy gums		Infantile scurvy	Scurvy	Guinea-pig scurvy	Ship beri-beri		
Nerve degeneration			Scurvy	Guinea-pig scurvy	Ship beri-beri	Beri-beri	Polyneuritis gallinarum
Cardiac hypertrophy and degeneration			Scurvy	Guinea-pig scurvy	Ship beri-beri	Beri-beri	Polyneuritis gallinarum
Dropsy				Guinea-pig scurvy	Ship beri-beri	Beri-beri	Polyneuritis gallinarum
Palsy						Beri-beri	Polyneuritis gallinarum

furnish new and additional facts which show the intimate relationship between scurvy and beri-beri as to ætiology. The affinities between these two diseases and certain other cachexias lend emphasis to the opinion that they are all the result of the continued use of a one-sided and deficient diet."

The necessary diet for the maintenance of health, besides sufficient protein, carbohydrates, fats, salts, &c., must contain the accessory food factors; the antineuritic water-soluble B; the fat-soluble A; and the antiscurvy factor. It is with the last that we are here concerned.

Recognizing that this cannot be supplied by the preserved lime juice from West Indian sources as at present made, it has been my object to provide an efficient, portable, and palatable substitute for the use of ships as occasion requires, and for such expeditions as may be undertaken in Polar exploration, &c. For the last six months I have been experimenting at the Royal Naval College, Greenwich, with guinea-pigs, which are extremely susceptible to scurvy, to obtain such an antiscorbutic preparation to replace or add to the lime juice ration. The value of these experiments with guinea-pigs in relation to human scurvy has received abundant proof by experiments, using monkeys, carried out on similar lines by Barnes and Hume, Chick, Hume and Skelton, and others.

Much of the work done at Greenwich has not been original but was necessary before passing on to the methods of prevention and cure. The use of dried orange juice has been largely employed by Givens and McClugage, who found that in the fresh state it was equal to that of lemons, and that it retained its antiscurvy properties for a considerable time, but in their preparation a certain amount of heat was employed which diminishes the efficiency of the product. In the investigation carried out at Greenwich various methods of preparing the juice were tried, evaporation at 60° C., de-acidification, impregnation of filter paper, rapid drying, &c.

The final laboratory method evolved, and which has been continuously in use is as follows: The juice of fresh lemons is roughly filtered through muslin and then through filter paper under reduced pressure by means of a water pump. The filtered juice is evaporated, *in vacuo* over sulphuric acid at ordinary temperature (13·5° to 15·5° C.). The residue of non-crystallizable syrup is worked up into as stiff a paste as possible with a mixture of anhydrous lactose 97 per cent., gum tragacanth 3 per cent. The paste is cut up into sections each containing the juice of half a lemon. These are rolled, faced with the mixture, and pressed to assume the lozenge form. These tablets have been stored at 15°, 30°, and 37° C. for months, and have been employed in the experiments. The average yield of juice from one lemon is about 48 c.c., and each tablet contains the equivalent of 24 c.c. of unfiltered juice. The whole process takes about five days; no heat whatever is used.

Two series of experiments were carried out:—

(1) Using a basal diet of bran and oats, 60 c.c. of milk heated in a steam sterilizer for one hour and a quarter, and water *ad lib.* In this there was abundant water-soluble anti-beri-beri, and fat-soluble growth

factor. The control animals died between the thirtieth and fiftieth day with all the usual signs of guinea-pig scurvy and great loss of weight. The addition of Navy lime juice did not give any protection.

(2) In the second series Navy biscuit was used as the basal diet, to which was added steamed milk, 60 c.c., and lime water; on one day per week the biscuit was substituted by oats to supply the anti-beri-beri vitamine. Growth was well maintained for over a fortnight, then the weight rapidly decreased, scurvy signs were manifested, and death followed. Control animals with 20 grm. of fresh cabbage or 10 c.c. fresh de-acidified lime juice grew normally. Animals were given one-fifth of a tablet (= 4·8 c.c. fresh lemon juice), in solid form, by hand feeding. There was generally a loss of weight at first, but when they became accustomed to the diet the animals grew and remained healthy for over three months.

A further series was carried out to find the minimum amount of tablet which would act as a preventive dose. The daily amount was reduced to one-tenth (= 2·4 c.c. fresh lemon juice). In two animals this was sufficient, but in two others signs of paralysis appeared and they had to be placed on normal diet again; this was followed by recovery.

Keeping Properties.—Animals were also given tablets which had been stored for three months and more, and no loss of protective power was noticed. Tablets kept at 37° C. became dark in colour and softer, due to caramelization of the lactose, and this appears to affect to a slight extent the vitamine properties. In no instance were the tablets found to have become mouldy whether kept at room temperature or blood heat.

Therapeutic Action.—If administered to an animal following scurvy signs, which were not too marked, a cure was effected (fig. 8, p. 65), but if diarrhœa had set in, or a great loss of weight had occurred, the animals died.

As they have been so fully reported elsewhere, it is unnecessary to describe the scurvy symptoms in the animals or the post-mortem findings, such as muscular, mucous, periosteal and intestinal hæmorrhages, fragility of bones, disorganization of joints, &c., with general atrophy of the intestinal tract, but the condition of the suprarenal bodies, as emphasized by McCarrison, deserves further mention. He has shown that in guinea-pigs these organs are enlarged, hæmorrhagic, and have a reduced adrenalin content, and with this there is a tendency to secondary bacterial blood infections (found once in my cases). In my experiments the changes in the suprarenals of the scorbutic animals

were very marked. There was marked congestion of the whole gland, with diffused or circumscribed hæmorrhages and fatty degeneration of the cells chiefly affecting the cortical areas. The weight of the glands was roughly three times that found in healthy guinea-pigs.

The reduction of the normal secretion is, according to McCarrison, an early factor in the scurvy syndrome, and influences very clearly the metabolic changes in the animal—and he concluded that the evidence, so far available, points to the dependence of the functional perfection of the adrenal glands upon the adequate supply, in the food, of the accessory food factors of the various classes.

COMPARATIVE RESULTS.

Scurvy animals		Animal		Suprarenals	
		Original weight	Weight at death	Weight (mgrm.)	Milligrams per 100 grm. of body weight at death
No. 1. (1)	Died on forty-eighth day; hæmorrhages and joint signs. Suprarenals, local and diffused hæmorrhages	340	235	270 225	115 96
No. 2. (4)	Died on forty-fourth day; hæmorrhages and joint signs. Suprarenals: hæmorrhages and degeneration of cells in cortex	360	235	237 200	101 85
No. 3. (5)	Died on fifty-third day; mucous and muscular hæmorrhages. Suprarenals: diffuse hæmorrhages and slight fatty changes	340	270	255 225	94 83
No. 4. (8)	Died on forty-fourth day; joint signs. Suprarenals: intense hæmorrhagic condition of whole gland, fatty changes in cortex	320	240	185 175	77 73
No. 5. (31)	Killed on twenty-seventh day; hæmorrhages and joint signs; ophthalmia. Suprarenals: extreme fatty degeneration of cortical cells, slight hæmorrhages	370	260	220 182	85 70

Five Scurvy Animals—Suprarenal Bodies.
Average weight per 100 grm. body weight at time of death, 87·9 mgrm.

Six Normal Animals—Suprarenal Bodies.
Average weight per 100 grm. body weight at time of death, 25·8 mgrm.

Many observations have shown that the onset of scurvy is very gradual. Dr. J. R. Comrie, in an account of scurvy in Russian prisons,

stated that it might be four and a half months, but generally it is as long as six months, before symptoms are manifested. In the pre-scurvy stage, owing to the deprivation of antiscurvy factors, the metabolism of food is incomplete and a *positive* agent is added, which acts like a toxin, causing changes in the adrenals and their secretions, favouring the hæmorrhagic conditions which are such marked features of the declared disease.

The use of this concentrated preparation has shown that it has effective antiscurvy properties for animals. We may, therefore, with confidence, apply its use to man under conditions of service which preclude the regular provision of fresh fruit and other known preventive substances, such as when on detached duty in the Persian Gulf, West Coast of Africa, and in Arctic exploration. It could also be employed in the mercantile marine. Though it is not yet possible to say how long the activity of the retained antiscurvy vitamine will remain effective, it is probable that this will be of extended duration if the preparation is kept dry and cool. Dr. Chick, in her admirable work at Vienna, has found that 5 c.c. of lemon juice is a prophylactic dose for infants, therefore 24 c.c. would probably be ample for an adult (half lemon). The tablets dissolve fairly readily if added to water containing a small quantity of bicarbonate of soda, and it is suggested that these dissolved tablets, containing antiscurvy accessory factor, should be added to the ordinary non-active pleasant tasting lime juice at present issued.

For general service, when large quantities are required, the non-heated concentrated syrup, as obtained before being mixed with lactose, might be kept in bottles, and the equivalent of 24 c.c. of fresh lemon juice be given per man, after solution in water to which sugar has been added at the time of issue. It is probable that this syrup would keep without mould formation, and this aspect is at present under consideration.

In this investigation I am greatly indebted to Mr. R. C. Frederick for his able assistance in preparing the tablets used and to Sick Berth Steward A. Coules for his careful attention in feeding the animals. Finally I have to thank you for your sympathetic hearing of what is, I feel, a very incomplete treatment of the subject.

Diet			Number of animals	Length of experiment (days)	Results as regards—	
Special ration	Amount (grm.)	Basal diet			Growth	Occurrence of scurvy
Dried lemon juice =4·4 c.c.	One-fifth tablet	Bran and oats, heated milk	1	161	Good	Complete protection
Fresh lemon juice de-acidified	10 c.c.	Bran and oats, heated milk	1	120	Good	Complete protection
Fresh milk thirty-two days, then tablet added	60 c.c.	Bran and oats, water	1	110	Very good	Slight protection; scurvy appeared thirty-second day; cured by one-fifth tablet
Cabbage	20 grm.	Bran and oats, heated milk	1	114	Very good	Complete protection
None	—	Bran and oats, heated milk	7	29 to 52	None	Scurvy, five died; one cured by dried juice, one by cabbage
Dried lemon juice =4·4 c.c.	One-fifth tablet	Navy biscuit, heated milk, lime water	5	60 to 120	Good	Complete protection
Fresh lemon juice de-acidified	10 c.c.	Navy biscuit, heated milk	1	160	Very good	Complete protection
Old dried lemon juice at 15° C. =4·4 c.c.	One-fifth tablet	Navy biscuit, heated milk, lime water	2	112	Very good	Complete protection
Old dried lemon juice at 15° C. =2·2 c.c.	One-tenth tablet	Navy biscuit, heated milk, lime water	4	60 to 100	Very good	Two, complete protection, two showed signs and were treated
Old dried lemon juice at 37° C. =4·4 c.c. (1) (2)	One-fifth tablet	Navy biscuit, heated milk, lime water	2	70 to 100	Fair	(1) Complete protection; (2) slight scurvy signs, and loss of weight, cleared up on juice being doubled on thirty-first day
Navy lime juice de-acidified	10 c.c.	Navy biscuit, heated milk	1	37	None	Scurvy, died thirty-seventh day
None	—	Navy biscuit, heated milk, lime water	2	28 to 42	None	Scurvy, died twenty-eighth and forty-second day
Cabbage	20 grm.	Navy biscuit, heated milk, lime water	1	110	Very good	Complete protection

BIBLIOGRAPHY.

Barnes and Hume. *Biochem. Journ.*, November, 1919.
Chick and Dalyell. *Wien. klin. Wochenschr.*, December, 1919.
Chick and Delf. *Biochem. Journ.*, November, 1919.
Chick, Hume, and Skelton. *Lancet*, 1918, ii, 734.
Comrie, J. R. *Edin. Med. Journ.*, 1919.
Darling. *Journ. Amer. Med. Assoc.*, February, 1915.
Delf and Tozer. *Biochem. Journ.*, December, 1918, xii, 416.
Givins and McClugage. *Amer. Journ. Dis. of Child.*, July, 1919.
Heiss and Unger. *Biochem. Journ.*, June, 1919.
McCarrison, R. *Indian Journ. Med. Research*, vi, 275, 550.
Smith, A. Henderson. *Journ. Roy. Army Med. Corps*, 1919, xxxii, 93, 188.
Walshe, F. M. R. *Brit. Journ. Dis. of Child.*, 1918, xv, 258.
Willcox, W. H. *Proc. Roy. Soc. Med.*, xiii (Sect. Therap.), 7.

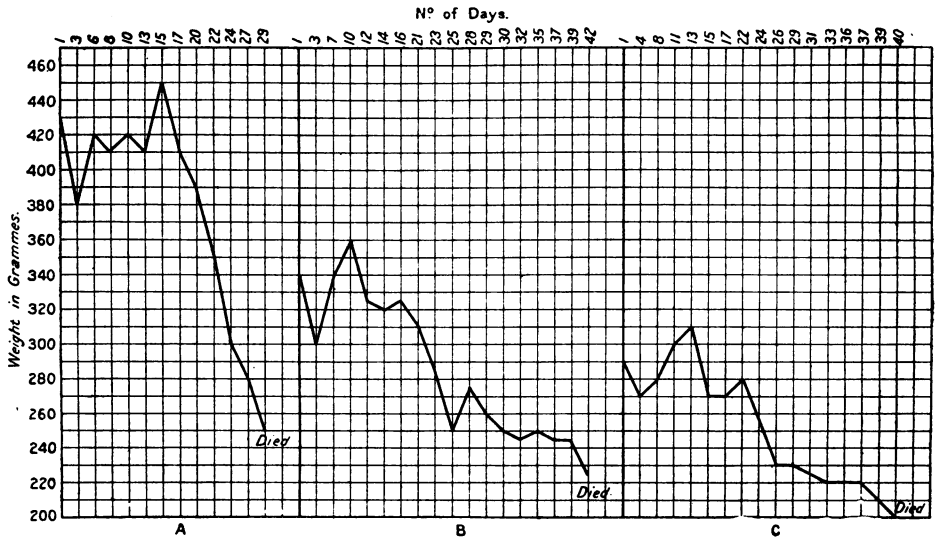

FIG. 2.

A—No. 23. Diet: Navy biscuit, 30 grm.; heated milk 60 c.c.; lime water, 20 c.c.
B—Composite Chart. Nos. 1, 2, 4, 7, 8. Diet: Bran and oats, 40 grm.; heated milk 60 c.c.
C—No. 16. Diet: Navy biscuit, 30 grm.; heated milk, 60 c.c.; Navy lime juice, 10 c.c.

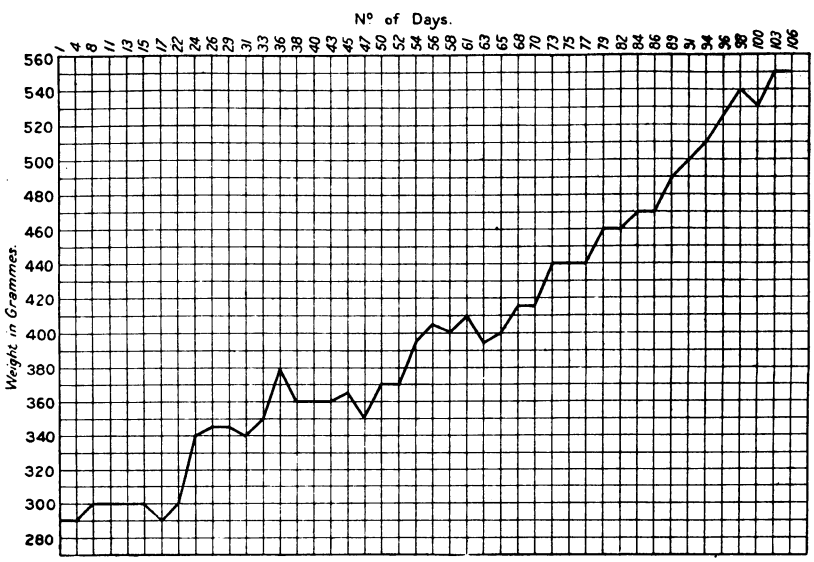

FIG. 3.

No. 15.—Diet: Navy biscuit, 40 grm.; heated milk, 60 c.c.; raw cabbage, 20 grm. daily.

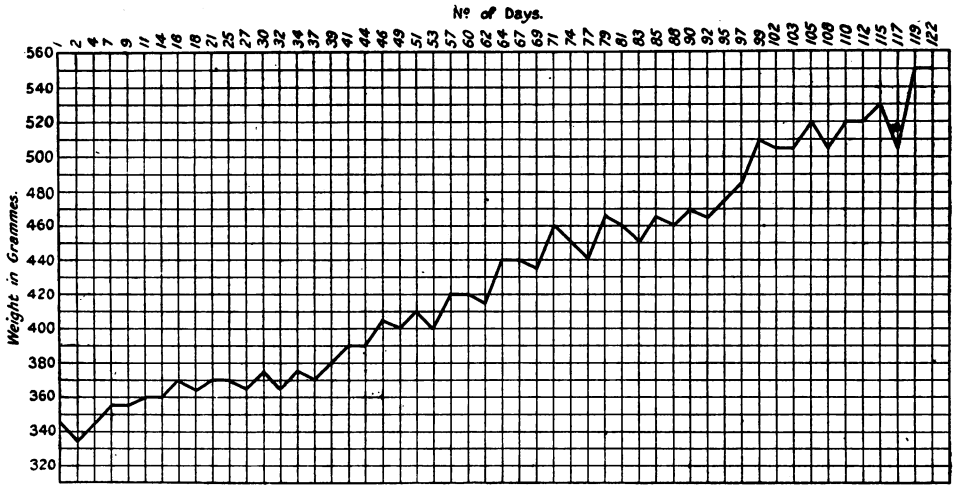

FIG. 4.

Composite Chart. Nos. 17, 18, 19, 20.—$\frac{1}{6}$ tablet dried juice. Diet : Biscuit, 30 grm. ; heated milk, 60 c.c. ; lime water, 20 c.c.

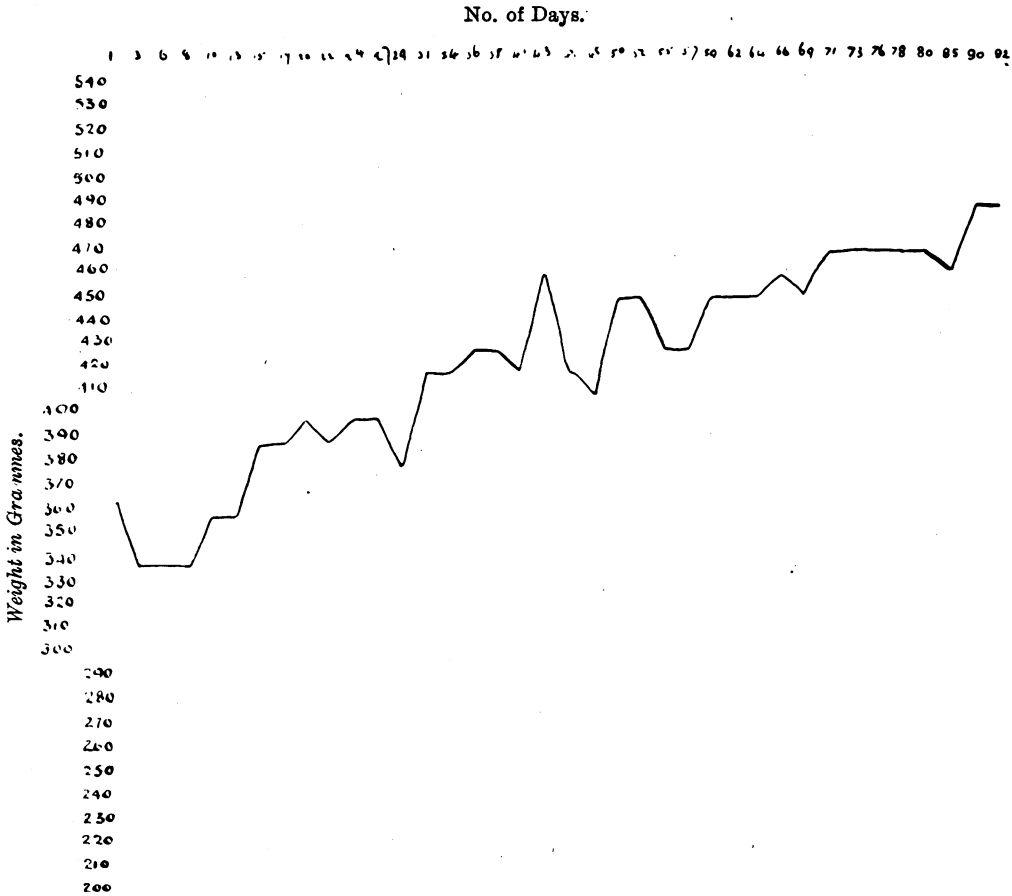

FIG. 5.

Biscuit, 30 grm. ; milk, 60 c.c. ; lime water, 20 c.c. ; old room temperature, dried juice, $\frac{1}{4}$-tablet.

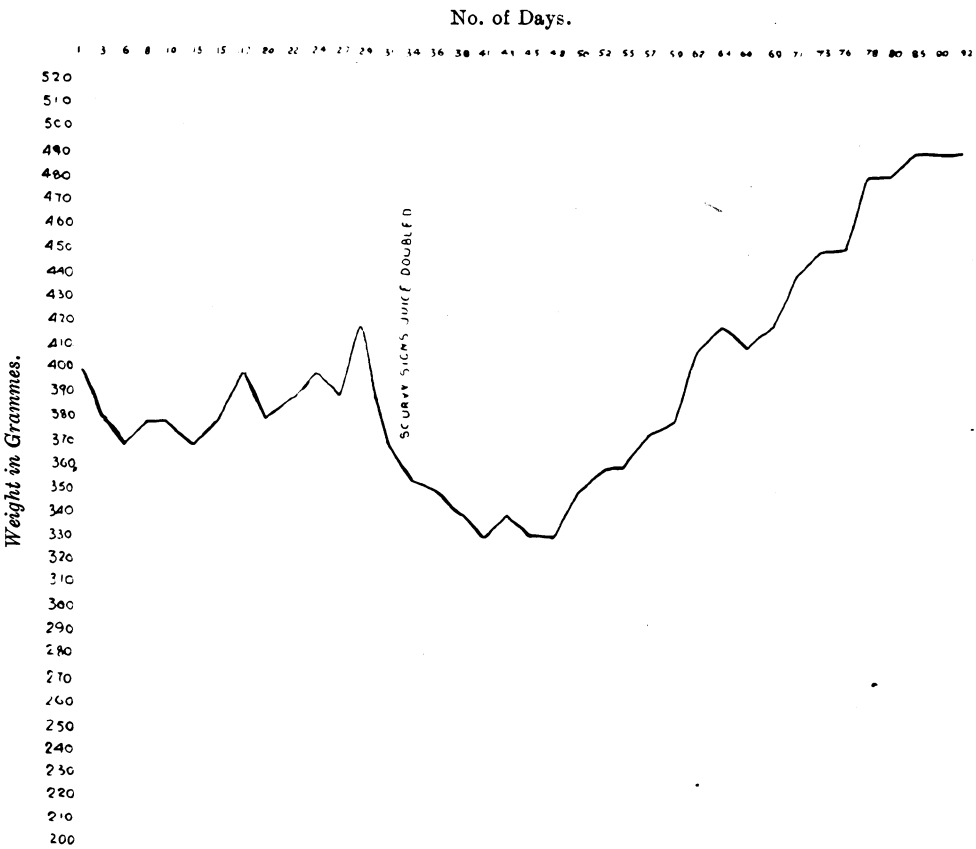

FIG. 6.

Navy biscuit, 30 grm.; heated milk, 60 c.c.; lime water, 20 c.c.; old dried juice at 37° C., $\frac{1}{5}$-tablet.

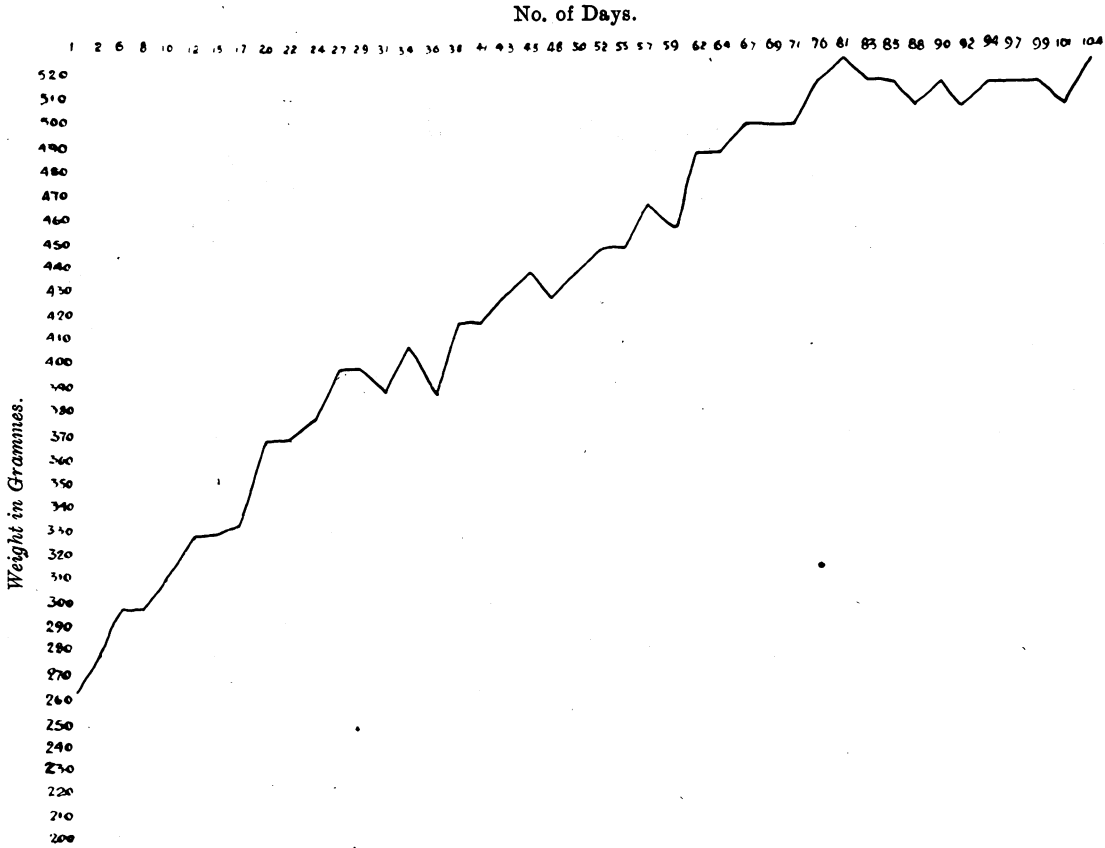

FIG. 7.

Navy biscuit, 40 grm..; heated milk, 60 c.c. ; old dried juice at 15° C., $\frac{1}{10}$-tablet ; lime water, 20 c.c.

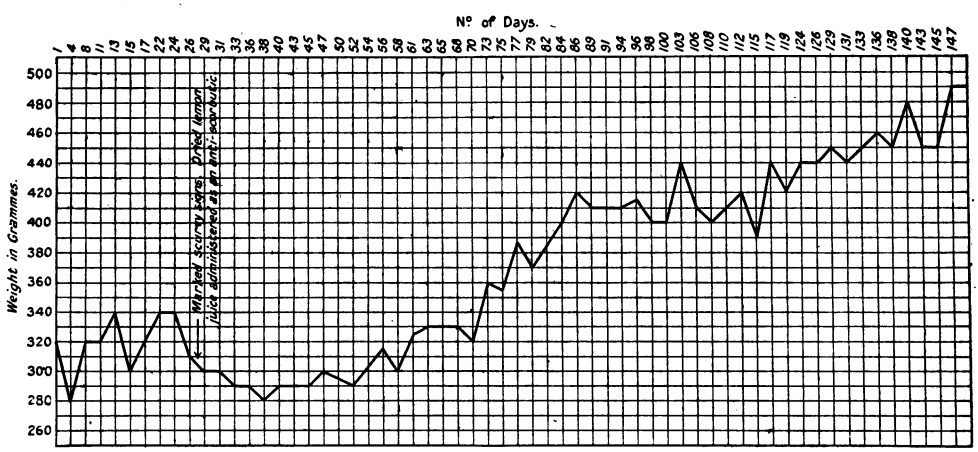

FIG. 8.

No. 3.—Diet : Bran and oats, 40 grm. ; heated milk, 60 c.c. $\frac{1}{5}$ tablet dried lemon juice on twenty-eighth day, when marked scurvy signs were present.

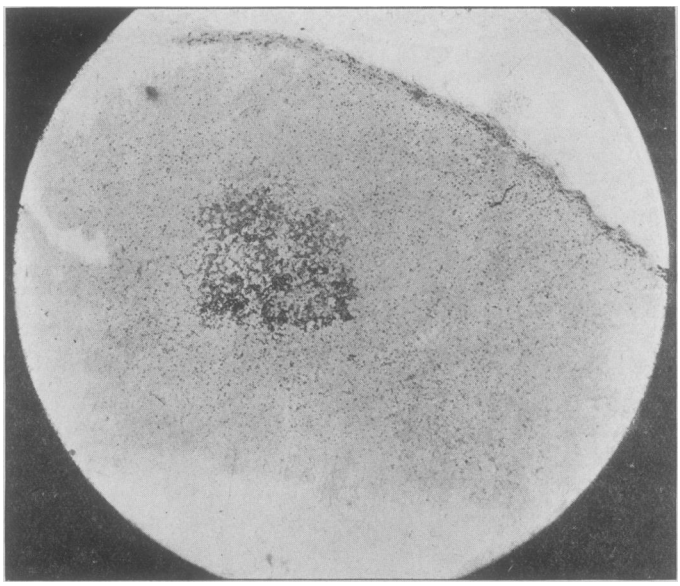

FIG. 9.

Guinea-pig No. 5. Died on fifty-third day; diffused hæmorrhage in the cortex of the suprarenal.

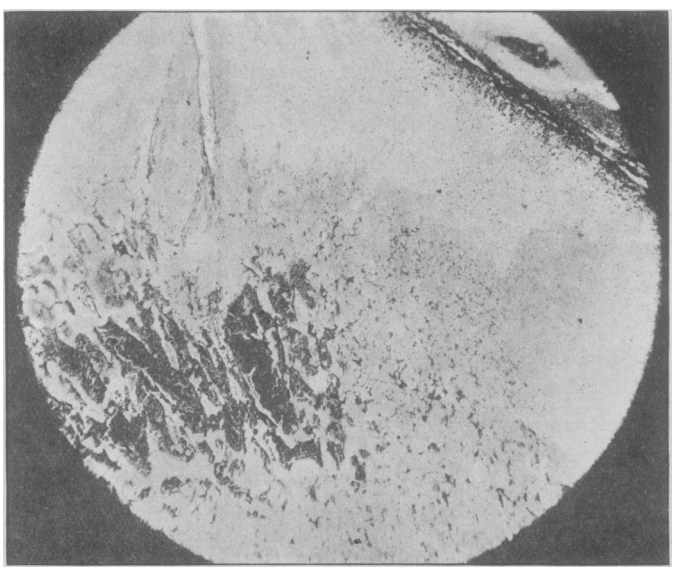

FIG. 10.

Guinea-pig No. 8. Died on forty-fourth day; intense congestion of suprarenal with extensive hæmorrhages in cortex.

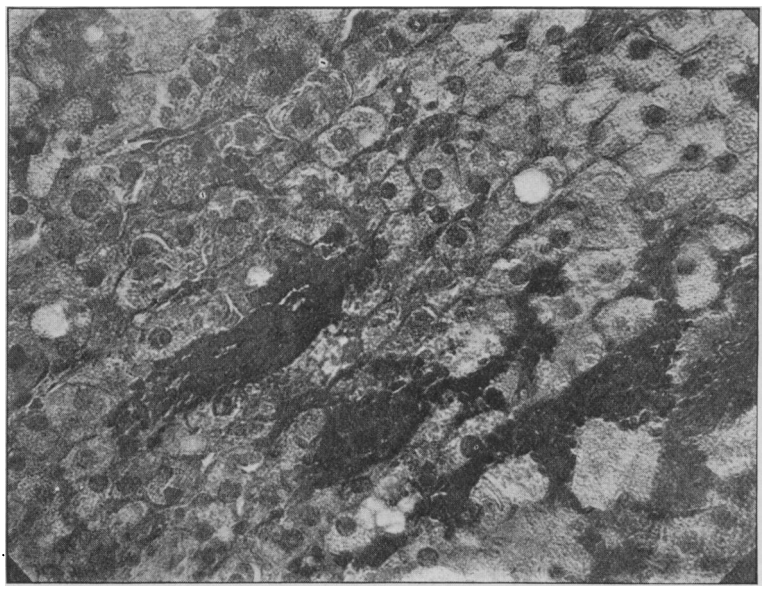

FIG. 11.

Guinea-pig No. 23. Died on thirtieth day; cortical hæmorrhages and fatty degeneration of suprarenal.

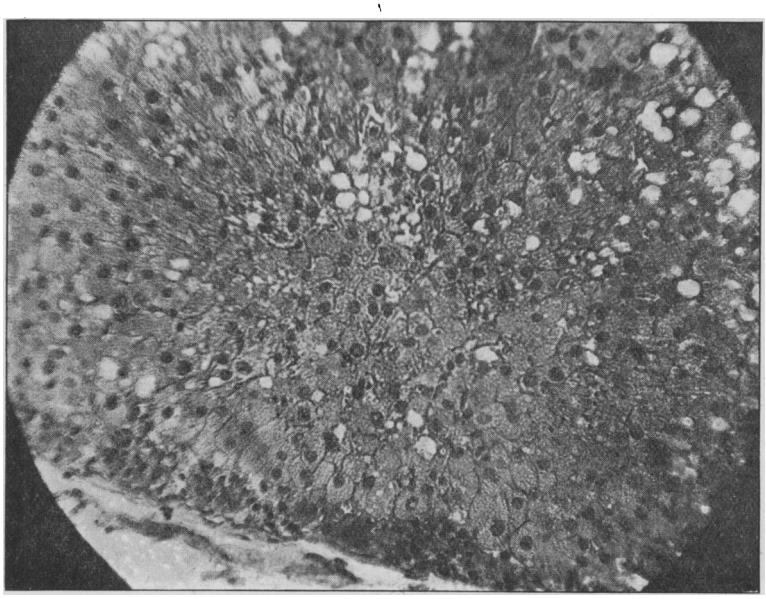

FIG. 12.

Guinea-pig No. 8. Died on forty-fourth day; very marked fatty changes in cortex, with slight hæmorrhages.

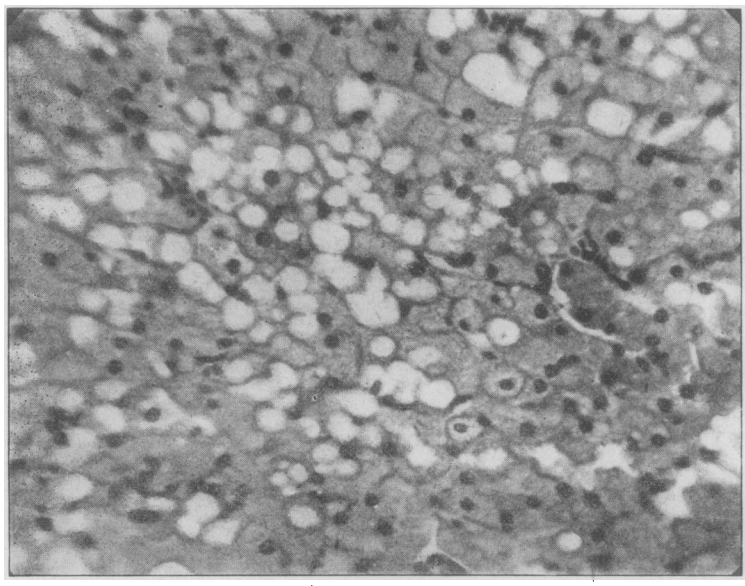

FIG. 13.

Guinea-pig No. 31. Killed on twenty-seventh day; intense fatty degeneration of suprarenal. (Under a higher magnification.)

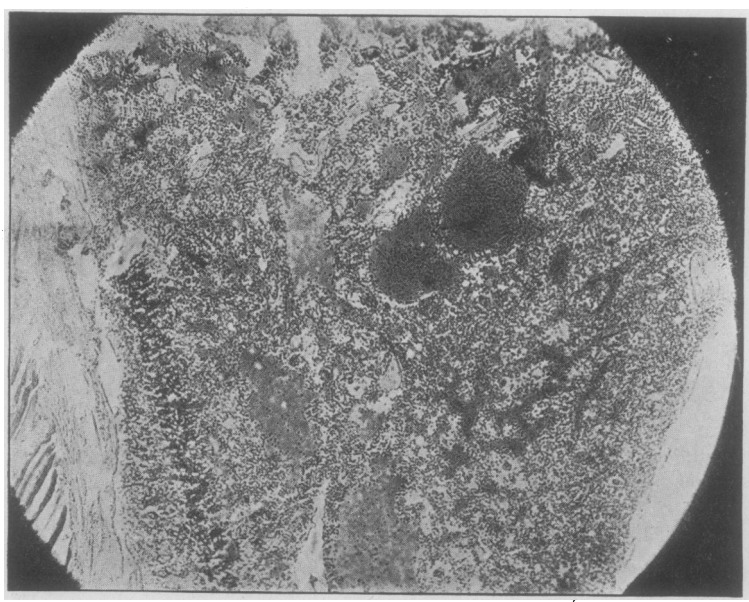

FIG. 14.

Guinea-pig No. 8. Died on forty-fourth day; intense hæmorrhages into medulla near epiphysis.

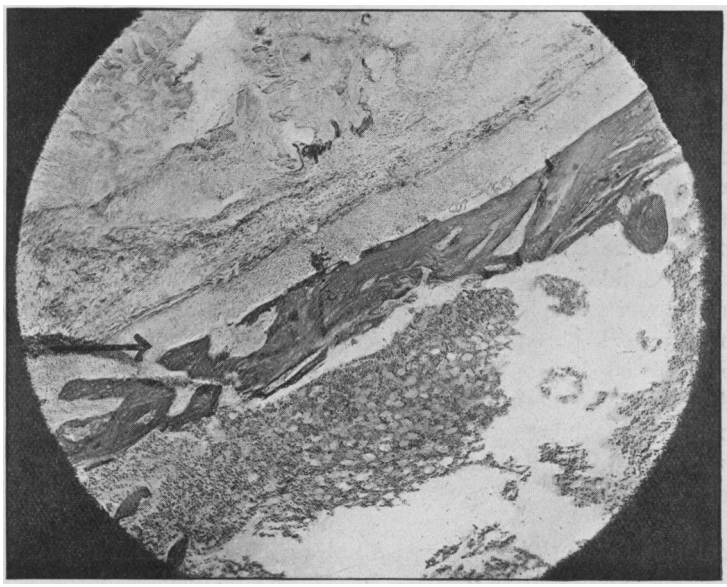

FIG. 15.

Guinea-pig No. 1. Died on forty-eighth day; sub-periosteal hæmorrhage.

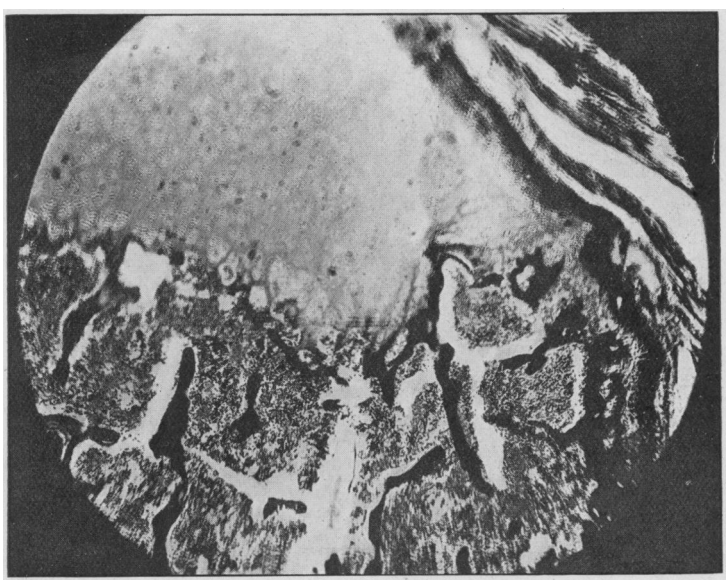

FIG. 16.

Guinea-pig No. 8. Died on forty-fourth day; costo-chondral junction, showing irregular line of ossification.

DISCUSSION.

Major-General Sir WILLIAM MACPHERSON: Scurvy in Mesopotamia, notwithstanding what Dr. W. H. Willcox has written on the subject, was not altogether due to want of recognition of its causes, but to the impossibility of getting fresh vegetable and other foods up to troops operating in certain areas. These foodstuffs became decomposed in consequence of climatic conditions before reaching the troops, and it was these troops which suffered most. As regards the resemblance between scurvy and beri-beri this was pointed out by myself in a report which is published in the official reports on the Russo-Japanese War. I observed thousands of cases of beri-beri amongst the Japanese, followed by some 20,000 cases of scurvy amongst the Russians in Port Arthur. The resemblance of the two cases clinically was so marked that it formed the subject of a special report. The cause amongst the Japanese was the use of highly milled and overcooked rice; and amongst the Russians the absence of fresh food and vegetables during the siege of Port Arthur.

Colonel S. L. CUMMINS: Rear-Admiral Bassett-Smith's paper has a great practical value. All who have heard or who will read the paper will recognize what this will mean to men of the naval and military and other forces, &c. Not only that, Rear-Admiral Bassett-Smith has come with his paper already in a practical form, and the method worked out and prepared ready for immediate adoption.